

CLAIMS

What is claimed is:

1. An occlusion clip comprising:

an upper occlusion member having substantially parallel first and second upper occlusion arms each having proximal and distal upper occlusion arm ends, the first and second upper occlusion arms defining an upper main body width dimension;

an upper arcuate portion connecting the first and second upper occlusion arms at their distal ends;

a lower occlusion member having substantially parallel first and second lower occlusion arms each having proximal and distal lower occlusion arm ends, the first and second lower occlusion arms defining a lower main body width dimension;

a lower arcuate portion connecting the first and second lower occlusion arms at their distal ends; and

a torsion spring connecting the proximal end of the first lower occlusion arm to the proximal end of the second upper occlusion arm, the torsion spring biasing the upper and lower occlusion members toward a closed position wherein the upper occlusion member is in contact with the lower occlusion member.

2. An occlusion clip according to claim 1 wherein the upper and lower occlusion members, the upper and lower arcuate portions and the torsion spring are formed from a single continuous wire segment having first and second wire ends.

3. An occlusion clip according to claim 2 wherein the wire segment is formed from one of titanium and stainless steel and has a diameter in a range from about 10 mils to about 40 mils.

4. An occlusion clip according to claim 2 wherein the wire segment is formed from one of titanium and stainless steel and has a diameter in a range from about 15 mils to about 30 mils.
5. An occlusion clip according to claim 2 wherein the torsion spring comprises a plurality of torsion coils at least partially disposed in a space between the first upper occlusion arm and the second upper occlusion arm, the plurality of torsion coils defining a central passage through the torsion spring.
6. An occlusion clip according to claim 5 wherein each of the torsion coils has a diameter less than about 0.100 inch when the occlusion clip is in its closed position.
7. An occlusion clip according to claim 5 further comprising:
 - a first free end member extending from the proximal end of the second lower occlusion arm and terminating at the first wire end, the first free end member being angled so that the first wire end is disposed within the central passage; and
 - a second free end member extending from the proximal end of the first upper occlusion arm and terminating at the second wire end, the second free end member being angled so that the second wire end is disposed within the central passage.
8. An occlusion clip according to claim 1 wherein the upper arcuate portion has a maximum upper arc width dimension along an axis that is coplanar with and perpendicular to the first and second upper occlusion arms and the lower arcuate portion has a maximum lower arc width dimension along an axis that is coplanar with and perpendicular to the first and second lower occlusion arms.
9. An occlusion clip according to claim 8 wherein the maximum upper arc width dimension and the maximum lower arc dimension are each approximately equal to an

overall maximum arc dimension and the upper main body width and the lower main body width are each approximately equal to an overall main body width dimension.

10. An occlusion clip according to claim 9 wherein the overall maximum arc dimension is greater than the overall main body width dimension.

11. An occlusion clip according to claim 9 wherein the maximum main body width dimension is less than about 0.100 inch.

12. An occlusion clip according to claim 1 wherein the torsion spring exerts a maximum biasing force of at least 0.4 pounds.

13. An occlusion clip according to claim 1 wherein a separation distance between the upper and lower occlusion members is established when the upper and lower occlusion members are separated to open the occlusion clip and wherein the biasing force of the torsion spring decreases as the separation distance increases.

14. An occlusion clip comprising:

an upper occlusion member having substantially parallel first and second upper occlusion arms each having proximal and distal upper occlusion arm ends, the first and second upper occlusion arms defining an upper main body width dimension;

an upper arcuate portion connecting the first and second upper occlusion arms at their distal ends, the upper arcuate portion having a maximum upper arc width dimension along an axis that is coplanar with and perpendicular to the first and second upper occlusion arms, the upper arc width dimension being greater than the upper main body width dimension;

a lower occlusion member having substantially parallel first and second lower occlusion arms each having proximal and distal lower occlusion arm ends, the first and second lower occlusion arms defining a lower main body width

dimension that is approximately equal to the upper main body width dimension;

a lower arcuate portion connecting the first and second lower occlusion arms at their distal ends, the lower arcuate portion having a maximum lower arc width dimension along an axis that is coplanar with and perpendicular to the first and second lower occlusion arms, the maximum lower arc width dimension being approximately equal to the maximum upper arc width dimension; and

a torsion spring connecting the proximal end of the first lower occlusion arm to the proximal end of the second upper occlusion arm, the torsion spring biasing the upper and lower occlusion members toward a closed position wherein the upper occlusion member is in contact with the lower occlusion member.

15. An occlusion clip according to claim 14 wherein the upper and lower occlusion members, the upper and lower arcuate portions and the torsion spring are formed from a single continuous wire segment having first and second wire ends.

16. An occlusion clip according to claim 15 wherein the wire segment is formed from one of titanium and stainless steel and has a diameter in a range from about 10 mils to about 40 mils.

17. An occlusion clip according to claim 15 wherein the wire segment is formed from one of titanium and stainless steel and has a diameter in a range from about 15 mils to about 30 mils.

18. An occlusion clip according to claim 15 wherein the torsion spring comprises a plurality of torsion coils at least partially disposed in a space between the first upper occlusion arm and the second upper occlusion arm, the plurality of torsion coils defining a central passage through the torsion spring.

19. An occlusion clip according to claim 18 wherein each of the torsion coils has a diameter less than about 0.100 inch when the occlusion clip is in its closed position.
20. An occlusion clip according to claim 18 further comprising:
 - a first free end member extending from the proximal end of the second lower occlusion arm and terminating at the first wire end, the first free end member being angled so that the first wire end is disposed within the central passage; and
 - a second free end member extending from the proximal end of the first upper occlusion arm and terminating at the second wire end, the second free end member being angled so that the second wire end is disposed within the central passage.
21. An occlusion clip according to claim 14 wherein the upper main body width dimension is less than about 0.100 inch.
22. An occlusion clip according to claim 14 wherein the torsion spring exerts a maximum biasing force of at least 0.4 pounds.
23. An occlusion clip according to claim 14 wherein a separation distance between the upper and lower occlusion members is established when the upper and lower occlusion members are separated to open the occlusion clip and wherein the torsion spring exerts a biasing force that decreases as the separation distance increases.
24. An occlusion clip comprising:
 - an upper occlusion member having substantially parallel first and second upper occlusion arms, each having proximal and distal upper occlusion arm ends;
 - a lower occlusion member having substantially parallel first and second lower occlusion arms, each having proximal and distal lower occlusion arm ends, the first lower occlusion arm being substantially parallel to the first upper occlusion arm and the second lower occlusion arm being substantially

parallel to the second upper occlusion arm when the occlusion clip is in a closed configuration wherein the upper occlusion member is in contact with the lower occlusion member; and

a torsion spring having a plurality of coils connecting a proximal end of the first lower occlusion arm to the proximal end of the second upper occlusion arm, the torsion spring providing a pivot axis for rotational separation of the upper occlusion member and the lower occlusion member and providing a biasing force to bias the occlusion clip toward the closed configuration.

25. An occlusion clip according to claim 24 wherein the biasing force decreases as a rotational separation between the upper occlusion member and the lower occlusion member increases.
26. An occlusion clip according to claim 24 wherein the torsion spring exerts a maximum biasing force of at least 0.4 pounds.
27. An occlusion clip according to claim 24 wherein the upper and lower occlusion members, and the torsion spring are formed from a single continuous wire segment having first and second wire ends.
28. An occlusion clip according to claim 27 wherein the wire segment is formed from one of titanium and stainless steel and has a diameter in a range from about 10 mils to about 40 mils.
29. An occlusion clip according to claim 27 wherein the wire segment is formed from one of titanium and stainless steel and has a diameter in a range from about 15 mils to about 30 mils.

30. An occlusion clip according to claim 27 wherein the plurality of torsion coils define a central passage through the torsion spring, the occlusion clip further comprising:

- a first free end member extending from the proximal end of the second lower occlusion arm and terminating at the first wire end, the first free end member being angled so that the first wire end is disposed within the central passage; and
- a second free end member extending from the proximal end of the first upper occlusion arm and terminating at the second wire end, the second free end member being angled so that the second wire end is disposed within the central passage.

31. An occlusion clip applicator comprising:

- a jaw push tube having proximal and distal push tube ends and a jaw push tube interior;
- an elongate clip holder formed as a channel having first and second support rails attached thereto, the first and second support rails being substantially parallel and in alignment with each other, the clip holder having proximal and distal clip holder ends and being disposed inside the jaw push tube interior;
- a clip pusher having an elongate support member having upper and lower sides with a plurality of clip push fingers attached to the lower side, the support member being mounted within the jaw push tube interior substantially parallel to the clip holder with at least a portion of each clip push finger extending downward into the channel; and
- a pair of jaws, each jaw having proximal and distal jaw ends, an inner engaging side and an opposite outer side, a clip slot formed through the jaw from the inner engaging side to the outer side and extending distally from and through the proximal jaw end, and a pair of parallel support shelves bounding at least a portion of the clip slot, the jaws being pivotably

mounted at their proximal ends to the distal clip holder end and being configured for engagement by the distal tube end for selective rotation between a fully open position and a closed position wherein the engaging sides of the jaws are in contact with each other.

32. An occlusion clip applicator according to claim 31 wherein the clip slot terminates in an ejection opening adjacent the distal jaw end, the clip slot having a slot width and the ejection opening having an ejection opening width that is greater than the slot width.
33. An occlusion clip applicator according to claim 32 wherein the jaws each have a pair of ramps bounding a proximal portion of the clip slot, the ramps being aligned with the support shelves and the support rails of the clip holder.
34. An occlusion clip applicator according to claim 31 wherein the support rails define a gap between the support rails, the gap being sized so that a first portion of an occlusion clip is narrower than the gap and so that a second portion of the occlusion clip is wider than the gap thus allowing the clip to be slidably disposed in the clip holder with the second portion of the clip engaging the support rails.
35. An occlusion clip applicator according to claim 34 wherein the clip push fingers each terminate in a clip engagement foot configured to engage a third portion of the occlusion clip so that distal movement of the clip pusher causes the occlusion clip to slide distally along the support rails.
36. An occlusion clip applicator according to claim 31 further comprising:
 - means for selectively moving the jaw push tube in a distal direction to engage the jaws and cause them to rotate from the open position to the closed position; and
 - means for selectively moving the clip pusher in the distal direction to cause distal movement of at least one occlusion clip disposed in the clip holder.

37. An occlusion clip applicator according to claim 36 wherein the means for selectively moving the jaw push tube and the means for selectively moving the clip pusher are adapted for moving the jaw push tube and the clip pusher in a predetermined sequence initiated by a user.
38. An occlusion clip applicator according to claim 31 further comprising:
an actuator operatively associated with the jaw push tube and the clip pusher and configured to produce selective distal and proximal movement of the jaw push tube and the clip pusher relative to the clip holder.
39. An occlusion clip applicator according to claim 38 wherein the actuator is adapted to produce the distal movement of the jaw push tube and the clip pusher in a predetermined sequence initiated by a user.
40. An occlusion clip applicator according to claim 38 further comprising:
a tube housing defining a tube chamber, the proximal push tube end, the proximal clip holder end and at least a portion of the actuator being disposed in the tube chamber.
41. An occlusion clip applicator according to claim 40 further comprising:
a handle assembly attached to the tube housing, the handle assembly having a handgrip with a handgrip interior space and a trigger rotatably mounted to the handgrip, the trigger being operatively associated with the actuator for selective activation thereof.
42. An occlusion clip applicator for storing and applying a plurality of occlusion clips each having an upper occlusion member having substantially parallel first and second upper occlusion arms connected by an upper arcuate portion at their distal ends and a lower occlusion member having substantially parallel first and second lower occlusion arms connected by a lower arcuate portion and a torsion spring connecting a proximal end of the first lower occlusion arm to a proximal end of the second upper occlusion

arm, the upper and lower occlusion members defining a main body width and a maximum arcuate portion width greater than the main body width, the torsion spring providing a pivot axis for rotational separation of the upper occlusion member and the lower occlusion member and providing a biasing force to bias the occlusion clip toward a closed configuration, the applicator comprising:

- a jaw push tube having proximal and distal push tube ends and a jaw push tube interior;
- an elongate clip holder configured to hold the plurality of occlusion clips, the clip holder being formed as a channel having first and second support rails attached thereto, the first and second support rails being substantially parallel and in alignment with each other and defining a gap with a gap width dimension that is greater than the main body width of the occlusion clips and less than the maximum arcuate width of the occlusion clips, the clip holder having proximal and distal clip holder ends and being disposed inside the jaw push tube interior;
- a clip pusher having an elongate support member having upper and lower sides with a plurality of clip push fingers attached to the lower side, the support member being mounted within the jaw push tube interior substantially parallel to the clip holder with at least a portion of each clip push finger extending downward into the channel; and
- a pair of jaws, each jaw having proximal and distal jaw ends, an inner engaging side and an opposite outer side, a clip slot formed through the jaw from the inner engaging side to the outer side and extending distally from and through the proximal jaw end, and a pair of parallel support shelves bounding at least a portion of the clip slot, the jaws being pivotably mounted at their proximal ends to the distal clip holder end and being configured for engagement by the distal tube end for selective rotation between a fully open position and a closed position wherein the engaging

sides of the jaws are in contact with each other, wherein the clip slot has a width dimension that is greater than the main body width of the occlusion clips and less than the maximum arcuate width of the occlusion clips.

43. An occlusion clip applicator according to claim 42 wherein the clip slot terminates in an ejection opening adjacent the distal jaw end, the ejection opening having an ejection opening width that is greater than the maximum arcuate width of the occlusion clips.
44. An occlusion clip applicator according to claim 42 wherein the jaws each have a pair of ramps bounding a proximal portion of the clip slot, the ramps being aligned with the support shelves and the support rails of the clip holder.
45. An occlusion clip applicator according to claim 42 wherein the clip push fingers each terminate in a clip engagement foot configured to engage the upper arcuate portions of the occlusion clips so that distal movement of the clip pusher causes the occlusion clips to slide distally along the support rails.
46. An occlusion clip applicator according to claim 42 further comprising:
 - means for selectively moving the jaw push tube in a distal direction to engage the jaws and cause them to rotate from the open position to the closed position; and
 - means for selectively moving the clip pusher in the distal direction to cause distal movement of at least one occlusion clip disposed in the clip holder.
47. An occlusion clip applicator according to claim 46 wherein the means for selectively moving the jaw push tube and the means for selectively moving the clip pusher are adapted for moving the jaw push tube and the clip pusher in a predetermined sequence initiated by a user.

48. An occlusion clip applicator according to claim 42 further comprising:
 - an actuator operatively associated with the jaw push tube and the clip pusher and configured to produce selective distal and proximal movement of the jaw push tube and the clip pusher relative to the clip holder.
49. An occlusion clip applicator according to claim 48 wherein the actuator is adapted to produce the distal movement of the jaw push tube and the clip pusher in a predetermined sequence initiated by a user.
50. An occlusion clip applicator according to claim 48 further comprising:
 - a tube housing defining a tube chamber, the proximal push tube end, the proximal clip holder end and at least a portion of the actuator being disposed in the tube chamber.
51. An occlusion clip applicator according to claim 50 further comprising:
 - a handle assembly attached to the tube housing, the handle assembly having a handgrip with a handgrip interior space and a trigger rotatably mounted to the handgrip, the trigger being operatively associated with the actuator for selective activation thereof.
52. An occlusion clip applicator comprising:
 - a handle assembly having a trigger and a handgrip with a handgrip interior space;
 - a tube housing attached to the handle assembly and defining a tube chamber in communication with the handgrip interior space, the tube chamber and the handgrip interior space combining to form an actuator space;
 - an actuator disposed in the actuator space, the actuator configured for engagement and selective actuation by the trigger;

a jaw push tube having a proximal tube end attached to the actuator and a distal tube end, a portion of the jaw push tube being slidably disposed within the tube housing;

a clip holder formed as a channel having opposing first and second side wall members and a base member defining a clip holder interior, a first support rail attached to the first side wall member and projecting into the clip holder interior and a second support rail attached to the second side wall member and projecting into the clip holder interior, the first and second support rails being substantially parallel and in alignment with each other, the clip holder having proximal and distal clip holder ends and being disposed inside the jaw push tube;

a clip pusher having an elongate support member having upper and lower sides with a plurality of clip push fingers attached to the lower side, the support member being mounted within the jaw push tube interior substantially parallel to the clip holder with at least a portion of each clip push finger extending downward into the channel; and

a jaw assembly comprising upper and lower jaws, each jaw having proximal and distal jaw ends and being pivotably mounted at its proximal end to the clip holder adjacent the distal clip holder end and configured for engagement by the distal tube end for selective rotation between a fully open position and a closed position, the upper and lower jaws each having a pair of support shelves bounding a central clip slot extending from and through the proximal jaw end to an ejection passage adjacent the distal jaw end.

53. An occlusion clip applicator according to claim 52 wherein the clip slot terminates in an ejection opening adjacent the distal jaw end, the clip slot having a slot width and the ejection opening having an ejection opening width that is greater than the slot width.

54. An occlusion clip applicator according to claim 52 wherein the jaws each have a pair of ramps bounding a proximal portion of the clip slot, the ramps being aligned with the support shelves and the support rails of the clip holder.
55. An occlusion clip applicator according to claim 52 wherein the support rails define a gap between the support rails, the gap being sized so that a first portion of an occlusion clip is narrower than the gap and so that a second portion of the occlusion clip is wider than the gap, thus allowing the clip to be slidably disposed in the clip holder with the second portion of the clip engaging the support rails.
56. An occlusion clip applicator according to claim 55 wherein the clip push fingers each terminate in a clip engagement foot configured to engage a third portion of the occlusion clip so that distal movement of the clip pusher causes the occlusion clip to slide distally along the support rails.
57. A method of occluding a fallopian tube of a patient using an occlusion clip having an upper occlusion member having substantially parallel first and second upper occlusion arms connected by an upper arcuate portion at their distal ends and a lower occlusion member having substantially parallel first and second lower occlusion arms connected by a lower arcuate portion and a torsion spring connecting a proximal end of the first lower occlusion arm to a proximal end of the second upper occlusion arm, the upper and lower occlusion members defining a main body width and a maximum arcuate portion width greater than the main body width, the torsion spring providing a pivot axis for rotational separation of the upper occlusion member and the lower occlusion member and providing a biasing force to bias the occlusion clip toward a closed configuration, the method comprising:

inserting a first trocar port through an abdominal wall defining an abdominal cavity of the patient;

inserting a second trocar port through the abdominal wall of the patient;

insufflating the abdominal cavity;

inserting an endoscopic camera through the first trocar port to locate and observe the fallopian tube;

inserting the occlusion clip through the second trocar port;

opening the occlusion clip by rotating the upper occlusion member away from the lower occlusion member;

positioning the occlusion clip so that a portion of the fallopian tube is positioned between the upper occlusion member and the lower occlusion member; and releasing the upper and lower occlusion members to engage and occlude the fallopian tube.

58. A method of occluding a fallopian tube according to claim 57 wherein the steps of inserting the occlusion clip, opening the occlusion clip, positioning the occlusion clip and releasing the upper and lower occlusion members to engage and occlude the fallopian tube are carried out using an applicator adapted to store and selectively apply a plurality of occlusion clips.

59. A method according to claim 58 wherein the applicator has a pair of jaws adapted for selectively engaging the fallopian tube, a jaw push tube configured for opening and closing the jaws, a clip holder disposed in the jaw push tube and configured for holding the plurality of clips, a clip pusher configured for moving the plurality of clips in the distal direction toward and onto the jaws and an actuator for selectively actuating the jaw push tube and the clip pusher.

60. A method according to claim 59 wherein the applicator has a handgrip and a trigger pivotably attached to the handgrip, the trigger being operatively associated with the actuator and wherein the steps of opening the occlusion clip, positioning the occlusion clip and releasing the upper and lower occlusion members to engage and occlude the fallopian tube are initiated by rotating the trigger in a continuous motion.

61. A method of occluding a fallopian tube of a patient using an occlusion clip having an upper occlusion member having substantially parallel first and second upper occlusion arms connected by an upper arcuate portion at their distal ends and a lower occlusion member having substantially parallel first and second lower occlusion arms connected by a lower arcuate portion and a torsion spring connecting a proximal end of the first lower occlusion arm to a proximal end of the second upper occlusion arm, the upper and lower occlusion members defining a main body width and a maximum arcuate portion width greater than the main body width, the torsion spring providing a pivot axis for rotational separation of the upper occlusion member and the lower occlusion member and providing a biasing force to bias the occlusion clip toward a closed configuration, the method comprising:

inserting a trocar port through an abdominal wall defining an abdominal cavity of the patient;

insufflating the abdominal cavity;

inserting a laparoscope through the first trocar port to locate and observe the fallopian tube;

inserting the occlusion clip through the second trocar port;

opening the occlusion clip by rotating the upper occlusion member away from the lower occlusion member;

positioning the occlusion clip so that a portion of the fallopian tube is positioned between the upper occlusion member and the lower occlusion member; and

releasing the upper and lower occlusion members to engage and occlude the fallopian tube.

62. A method of occluding a fallopian tube according to claim 61 wherein the steps of inserting the occlusion clip, opening the occlusion clip, positioning the occlusion clip and releasing the upper and lower occlusion members to engage and occlude the fallopian tube are carried out using an applicator adapted to store and selectively apply a plurality of occlusion clips.

63. A method according to claim 62 wherein the applicator has a pair of jaws adapted for selectively engaging the fallopian tube, a jaw push tube configured for opening and closing the jaws, a clip holder disposed in the jaw push tube and configured for holding the plurality of clips, a clip pusher configured for moving the plurality of clips in the distal direction toward and onto the jaws and an actuator for selectively actuating the jaw push tube and the clip pusher.
64. A method according to claim 63 wherein the applicator has a handgrip and a trigger pivotably attached to the handgrip, the trigger being operatively associated with the actuator and wherein the steps of opening the occlusion clip, positioning the occlusion clip and releasing the upper and lower occlusion members to engage and occlude the fallopian tube are initiated by rotating the trigger in a continuous motion.
65. A method of occluding a fallopian tube of a patient using first and second occlusion clips each having an upper occlusion member having substantially parallel first and second upper occlusion arms connected by an upper arcuate portion at their distal ends and a lower occlusion member having substantially parallel first and second lower occlusion arms connected by a lower arcuate portion and a torsion spring connecting a proximal end of the first lower occlusion arm to a proximal end of the second upper occlusion arm, the upper and lower occlusion members defining a main body width and a maximum arcuate portion width greater than the main body width, the torsion spring providing a pivot axis for rotational separation of the upper occlusion member and the lower occlusion member and providing a biasing force to bias the occlusion clip toward a closed configuration, the method comprising:

inserting a first trocar port through an abdominal wall defining an abdominal cavity of the patient;

inserting a second trocar port through the abdominal wall of the patient;

insufflating the abdominal cavity;

inserting an endoscopic camera through the first trocar port to locate and observe the fallopian tube;

inserting the first occlusion clip through the second trocar port;

opening the first occlusion clip by rotating the upper occlusion member of the first occlusion clip away from the lower occlusion member of the first occlusion clip;

positioning the first occlusion clip so that a first portion of the fallopian tube is positioned between the upper and lower occlusion members of the first occlusion clip;

releasing the upper and lower occlusion members of the first occlusion clip to engage and occlude the fallopian tube;

inserting the second occlusion clip through the second trocar port;

opening the second occlusion clip by rotating the upper occlusion member of the second occlusion clip away from the lower occlusion member of the second occlusion clip;

positioning the second occlusion clip so that a second portion of the fallopian tube is positioned between the upper and lower occlusion members of the second occlusion clip, the second portion of the fallopian tube being a predetermined distance along the fallopian tube from the first part of the fallopian tube; and

releasing the upper and lower occlusion members of the second occlusion clip to engage and occlude the fallopian tube.

66. A method of occluding a fallopian tube according to claim 65 wherein the predetermined distance is in a range from about 5 mm to about 10 mm.

67. A method of occluding a fallopian tube according to claim 65 wherein the steps of inserting the first and second occlusion clips, opening the first and second occlusion clips, positioning the first and second occlusion clips and releasing the upper and lower

occlusion members of the first and second occlusion clips to engage and occlude the fallopian tube are carried out using an occlusion clip applicator adapted for use with the first and second occlusion clips.

68. A method according to claim 67 wherein the applicator has a pair of jaws adapted for selectively engaging the fallopian tube, a jaw push tube configured for opening and closing the jaws, a clip holder disposed in the jaw push tube and configured for holding the first and second clips, a clip pusher configured for moving the first and second clips in the distal direction toward and onto the jaws and an actuator for selectively actuating the jaw push tube and the clip pusher.